The UMA Group

REGIONAL MUNICIPALITY

OF

HAMILTON-WENTWORTH

REPORT ON

TOWN OF DUNDAS

SEWAGE TREATMENT PLANT

ACTIVATED CARBON PROCESS

December 1974

Underwood McLellan & Associates Limited

89 Carlingview Drive, Rexdale (Toronto), Ontario M9W 5E4 Telephone (416) 677-6651

January 6, 1975 File #1931-01

Mr. W.A. Wheten, B.Sc., F.E.I.C., P. Eng.,
Commissioner of Engineering,
Regional Municipality of Hamilton-Wentworth,
P.O. Box 1058,
Hamilton,
Ontario.
L8N 3R4

Att: Mr. K. Brenner, P. Eng.

Dear Sirs:

Re: Town of Dundas - King Street
Sewage Treatment Plant

We have now completed our investigation on the use of activated carbon absorption to achieve a polished effluent at this plant when expanded to 4.0 mgd. The attached report outlines our findings.

You will note that the use of the activated carbon process to further reduce the quantity of BOD and suspended solids in the plant effluent involves a significant cost increase. Also, this process does not improve the removal of phosphorous.

We trust you will find this report satisfactory and that you will call us if there are any questions.

Yours very truly,

UNDERWOOD McLELLAN & ASSOCIATES LIMITED

M. Bruno, P. Eng.,
Manager - Eastern Region.

MB:rl
Encl.

REGIONAL MUNICIPALITY

OF

HAMILTON-WENTWORTH

REPORT ON

TOWN OF DUNDAS

SEWAGE TREATMENT PLANT

ACTIVATED CARBON PROCESS

December 1974

I N D E X

INTRODUCTION

On November 14, 1974, Underwood McLellan & Associates Limited were instructed to determine costs and feasibility of utilizing the activated carbon process to improve effluent quality at Dundas Sewage Treatment Plant, expanded to 4.0 mgd. The Sewage Treatment Plant is to be contained on the present site as concluded in our report of September 1974, which considered the plant development program relative to the utilization of the existing site for the initial expansion requirements or the Desjardins Estate site.

In September 1974, Council of the Regional Municipality of Hamilton-Wentworth adopted the Engineering Committee report to Council for the expansion of the plant on the existing site. The Ministry of the Environment is presently evaluating the completeness of the data available on Cootes Paradise.

Representatives of various environmental interest groups have expressed a desire for the provision of a treatment facility capable of providing an effluent suitable for discharge to the Desjardins Canal. Alternatively, an outlet could be constructed to discharge the treated effluent to the Hamilton Harbour.

This report considers the costs associated with the provision of activated carbon absorption of the final effluent in relation to the other programs previously reported.

SUMMARY AND RECOMMENDATIONS

The report has considered the use of activated carbon to achieve a high degree of treatment at the Town of Dundas Sewage Treatment Plant. The following conclusions can be drawn:

1. A population growth rate of 10% per annum will result in a lower cost per 1000 gallons treated when compared to a 5% growth rate.

2. Continuing inflation in the region of 10% annually will be reflected in a significant increase annually in the operational and maintenance costs. Annual cost increases due to inflation exceeds the population rate increase with the result that the rate cost per 1000 gallons is increased.

3. The use of the activated carbon process requires the achievement of a quality effluent from a biological plant.

4. The most economical activated carbon absorption system will result in an increased cost of approximately 28.5¢/1000 gallons with a population growth rate of 10% per annum. A conventional plant with discharge to the Desjardins Canal will cost in the region of 52.3¢/1000 gallons on the same size basis.

5. The full benefit of the activated carbon process would only be achieved through the provision of complete standby power, a surge tank to store sewage flows in excess of the maximum daily rate and an increase in plant operator attendance.

6. The activated carbon process can be expected to achieve an effluent BOD of 2-4 ppm, a suspended solids concentration of less than 2 ppm, and a phosphorus concentration of not less than 1 ppm. The activated carbon process offers no advantages with respect to phosphorus removal.

The total effect of the plant discharge on Cootes Paradise, as related to other forms of pollution, is not fully understood. A specific evaluation would involve an assessment of the quantity of pollution caused by atmospheric fallout and other sources. This would suggest that a staged implementation

program would be appropriate for the town. The program could provide for the initial construction of a conventional plant expansion to 4.0 mgd on the present site to be followed by the addition of further works as dictated by the conditions causing the reported pollution of Cootes Paradise. Such a program would ensure the expenditure of funds in areas which would bring about the greatest benefits for the protection of the environment.

DISCUSSION:

Conventional Activated Sludge Plant with Phosphorus Removal:

A conventional biological plant, including alum treatment for the removal of phosphorus, normally would require the provision of standby power facilities capable of maintaining emergency lighting in addition to enabling the continued operation of the primary treatment and effluent chlorination facilities. Multiple treatment units are provided in the plant, either initially or in the subsequent stages of development. However, mechanical equipment items, such as pumps, are provided to ensure that at least the firm requirements of the equipment is available with the largest unit out of service. A greater degree of emergency standby equipment may be warranted as indicated by local conditions.

Sewage flows up to a maximum daily rate (2.0 x daily average) would receive full treatment with flows in excess of this amount being discharged with the plant effluent following screening, grit removal and effluent chlorination.

In the case of the Town of Dundas, the present plant effluent is discharged to the Desjardins Canal and it is contemplated that this discharge to the Canal should continue to be permitted pending the evaluation of environmental conditions now existing in the West Pond and Cootes Paradise, and the establishment of the significance of all sources of pollution to these waters.

Outfall Sewer:

An outfall sewer could be constructed from either the existing plant site or the Desjardins Estate site, when required, to direct the treated effluent to the Hamilton Harbour. This facility would be required to carry all sewage flows received at the plant to ensure that sewage is not discharged to the Desjardins Canal. The pipe could be installed across the West Pond and Cootes Paradise, with little disruption to either waterway, using a plastic pipe which could be assembled on land, floated into position and sank on the mud bottom. The outlet structure at the terminal point of the pipe would include appropriate diffusion ports to achieve dispersion into the Harbour.

Such a facility would remove all possible sanitary sewage discharges to the West Pond and Cootes Paradise. A minimum discharge of acceptable effluent quality could be directed to the Desjardins Canal to maintain a minimum summer flow in the system. This discharge could be controlled through the use of regulating valves.

Activated Carbon Process:

The Underwood McLellan & Associates Limited report of September 1973 concluded that a biological treatment process of the activated sludge type was a necessary base on which to build other treatment facilities, should it become desirable to improve the effluent quality. This is due to the ability of the process to economically convert dissolved organics to a form suitable for removal.

The main advantage of this process is that it relies on atmospheric oxygen to biologically oxidize organics to carbon dioxide and water. Intermediate steps in the ultimate treatment process result in the production of sludges with a relatively high organic content. Complete aerobic oxidation is generally not economical and where an improved effluent quality is required, this is normally achieved through the addition of a treatment process that is capable of removing the remaining organics and suspended solids.

The biological process can be relied upon to produce an effluent quality of approximately 15 ppm concentration for BOD and suspended solids and 1.0 ppm concentration for phosphorus removal. Effluent filtration, utilizing a dual media, anthrafilt-sand filter, can further reduce these pollution indicators to 10 ppm for BOD, 5 ppm for suspended solids and 1.0 ppm for phosphorus. A further improvement in the effluent can be realized through the use of activated carbon absorption towers. These towers, which are filled with activated granulated carbon, are designed on the basis of quantity, pounds per day, of BOD and suspended solids to be removed and for large installations, include the continuous withdrawal of spent carbon, with the injection of regenerated activated carbon into the inlet to the towers. The carbon is regenerated

utilizing a multi hearth type furnace at a temperature of approximately 1700°F. An effluent quality with a BOD of 2-4 ppm, a suspended solids concentration of less than 2 ppm, and a phosphorus concentration of not less than 1 ppm, can be achieved. It should be noted that, after chemical precipitation of phosphorus in the biological treatment units, no further removal can be anticipated.

An effluent of this quality could be discharged safely to any substantial water body without dilution.

However, such a process should include the provision of additional facilities associated with the biological plant in order to achieve the full benefit of the high quality of effluent. It has previously been noted that flows in excess of the treatment capacity available in the secondary treatment plant are normally by-passed. It is estimated that this quantity approximates 5% to 10% of the annual sewage flows. A 4.0 mgd plant operating with a 4.0 ppm BOD effluent would discharge approximately 60,000 lbs. of BOD per year. A 5% discharge of excess sewage flows with a BOD of 70 ppm would indicate an annual discharge of approximately 50,000 lbs. of BOD. The 70 ppm concentration has been estimated on the basis that the raw sewage, with a normal BOD of 180 ppm, has been reduced through dilution with storm and infiltration water flows. Further, it should be noted that the sewage discharged without treatment would probably be more significant in terms of the effect on the receiving water as the pollutants are in a form that can be readily decomposed, which is not the case with the BOD remaining in the well treated effluent. Accordingly, it is suggested that such a process should include a high flow storage tank where the untreated sewage could be held without by-passing the treatment process for treatment when the excess flow has receded. Furthermore, it would be necessary to consider additional emergency facilities at both the biological and the activated carbon plants in order to realize the full benefit of the treatment process. This would include the provision of standby power for the entire plant to enable full treatment at all times in addition to the standby treatment units and mechanical equipment previously noted.

The basic design parameters considered to be essential for such a plant are included in Appendix 'C'. It should also be noted that it will be necessary to install pumps to transfer the biological plant effluent to the activated carbon plant

pressure filtration system. The activated carbon plant can be constructed west of the existing plant facilities. Similarly, a surge tank could be provided, but it should be noted that this would result in construction of open raw sewage storage facilities relatively close to present housing. The construction of these facilities east of the present plant is also possible, but this would require the complete abandonment of the ball diamond.

COST ESTIMATES

The cost estimates have been prepared on the basis of current costs for construction of this type following a review with contractors, equipment suppliers and by comparison with projects now being developed in our company. Accordingly, it is expected that the estimates represent a reasonable base on which to compare the alternative programs. However, it must be acknowledged that with the inflationary trend now being experienced, it is extremely difficult to prepare precise cost estimates, particularly as it relates to work with a relatively long period of construction.

The annual cost of capital has been calculated on the basis of a 20 year debenture bearing interest at the rate of 9%.

Operating and maintenance estimates have been based on 1974 costs with an assumed inflation of 10% annually. Estimates of population growth have been based on both a 5% and a 10% annual growth rate. It is suggested that these assumptions respecting inflation and growth rate are reasonable and should approximate the conditions that will occur in the future. A more rapid rate of inflation would result in increased operating and maintenance costs and in a greater divergence in the costs for alternatives with an initially high operating and maintenance cost as compared to those with lower costs in this category.

Appendices 'A' and 'B' include the computed costs vs. time for the various alternatives with Appendix 'A' being based on a 5% population growth rate and Appendix 'B' a 10% growth rate. Table 1 which follows is a summary of the resultant cost estimates included in Appendices 'A' and 'B'. It can be seen that the cost of the alternatives, including activated carbon as a method of treatment, exceed that for a conventional plant with an outlet to Hamilton Harbour.

This cost increase, averaged over the life of the plant, would amount to $362,000 per year or $242,000 per year for a 5% and 10% growth rate, respectively.

The alternatives enable the consideration of the merits of a variety of programs on the basis of cost comparisons. However, it has been concluded that the alternative with the lowest initial operating and maintenance cost represents the least cost over the life of the plant.

All of which is respectfully submitted.

UNDERWOOD McLELLAN & ASSOCIATES LIMITED

K.A. Reichert, P. Eng.,
Chief Sanitary Engineer.

KAR:rl

TABLE 1

TOWN OF DUNDAS

SUMMARY RATE COST, ¢/1,000 GAL., FOR SEWAGE TREATED FROM 1974 TO PLANT OPERATING AT DESIGN CAPACITY

ITEM	APPENDIX 'A' 5% GROWTH 1974-1989	APPENDIX 'B' 10% GROWTH 1974-1982
1. Conventional plant expansion to 4.0 mgd, P removal, outlet to Desjardins Canal at York Road, normal stand-by facilities, including Eng. and Cont.	70.0	52.3
2. Outlet from 4.0 mgd Plant to Hamilton Harbour including booster pump and Eng. and Cont.	24.0	22.8
3. High flow surge tank including Eng. & Cont.	12.4	10.3
4. Conventional plant expansion to 4.0 mgd, P removal, outlet to Desjardins Canal at York Road, complete stand-by facilities, effluent pumps, incl. Eng. & Cont.	78.5	58.3
5. Activated carbon plant with sand and carbon filters but without carbon regeneration, including Eng. & Cont.	83.9	58.1
6. Activated carbon plant with sand and carbon filters and carbon regeneration including Eng. & Cont.	36.7	28.5
7. Items 1 & 2 above comprise a complete system	94.0	75.1
8. Items 3, 4 and 6 above comprise a complete system and complete stand-by power	127.5	97.1

APPENDIX 'A'

TOWN OF DUNDAS
COST ESTIMATES FOR SEWAGE TREATMENT PLANT EXPANSION

Basis:

i. A 5 percent increase will occur annually in population growth and correspondingly in sewage flows.

ii. Operating and maintenance costs will increase 10 percent annually.

ALTERNATIVE NO. 1

Conventional plant expansion to 4.0 MGD, P removal, outlet to Desjardins Canal at York Road. Normal standby facilities, including engineering and contingencies.

Capital cost of $2.1M. Initial operating costs 20¢/1000 Gals.

Year	Sewage Flow M.G.D.	Annual Capital Cost	Annual Operating & Maintenance Cost	Total Annual Costs	Rate Cost ¢/1000 Gals.
1974	2.00	224,000	146,000	370,000	50.7
1975	2.10	224,000	168,630	392,630	51.2
1976	2.20	224,000	194,768	418,768	52.0
1977	2.32	224,000	224,957	448,957	53.1
1978	2.43	224,000	259,825	483,825	54.5
1979	2.55	224,000	300,098	524,098	56.3
1980	2.68	224,000	346,613	570,613	58.3
1981	2.81	224,000	400,338	624,338	60.8
1982	2.95	224,000	462,390	686,390	63.6
1983	3.10	224,000	534,061	758,061	66.9
1984	3.26	224,000	616,840	840,840	70.7
1985	3.42	224,000	712,450	936,450	75.0
1986	3.59	224,000	822,880	1,046,880	79.9
1987	3.77	224,000	950,427	1,174,427	85.3
1988	3.96	224,000	1,097,743	1,321,743	91.4
1989	4.16	224,000	1,267,893	1,491,893	98.3
	17,269.97	3,584,000	8,505,913	12,089,913	70.0

ALTERNATIVE NO. 2

Outlet from 4.0 MGD plant to Hamilton Harbour, including booster pump and engineering and contingencies.

Capital cost of $2,200,000.
Operating and maintenance costs 0.91¢/1000 Gals.

Year	Sewage Flow M.G.D.	Annual Capital Cost	Annual Operating & Maintenance Cost	Total Annual Costs	Rate Cost ¢/1000 Gals.
1974	2.00	235,000	6,643	241,643	33.1
1975	2.10	235,000	7,673	242,673	31.7
1976	2.20	235,000	8,862	243,862	30.3
1977	2.32	235,000	10,236	245,236	29.0
1978	2.43	235,000	11,822	246,822	27.8
1979	2.55	235,000	13,654	248,654	26.7
1980	2.68	235,000	15,771	250,771	25.6
1981	2.81	235,000	18,215	253,215	24.7
1982	2.95	235,000	21,039	256,039	23.7
1983	3.10	235,000	24,300	259,300	22.9
1984	3.26	235,000	28,066	263,066	22.1
1985	3.42	235,000	32,416	267,416	21.4
1986	3.59	235,000	37,441	272,441	20.8
1987	3.77	235,000	43,244	278,244	20.2
1988	3.96	235,000	49,947	284,947	19.7
1989	4.16	235,000	57,689	292,689	19.3
	17,269.97	3,760,000	387,019	4,147,019	24.0

ALTERNATIVE NO. 3

High flow surge tank, including engineering and contingencies.

Capital cost of $685,000.
Operating and maintenance costs 2.28¢/1000 Gals.

Year	Sewage Flow M.G.D.	Annual Capital Cost	Annual Operating & Maintenance Cost	Total Annual Costs	Rate Cost ¢/1000 Gals.
1974	2.00	73,000	16,644	89,644	12.3
1975	2.10	73,000	19,224	92,224	12.0
1976	2.20	73,000	22,204	95,204	11.8
1977	2.32	73,000	25,645	98,645	11.7
1978	2.43	73,000	29,620	102,620	11.6
1979	2.55	73,000	34,211	107,211	11.5
1980	2.68	73,000	39,514	112,514	11.5
1981	2.81	73,000	45,639	118,639	11.5
1982	2.95	73,000	52,712	125,712	11.7
1983	3.10	73,000	60,883	133,883	11.8
1984	3.26	73,000	70,320	143,320	12.1
1985	3.42	73,000	81,219	154,219	12.4
1986	3.59	73,000	93,808	166,808	12.7
1987	3.77	73,000	108,349	181,349	13.2
1988	3.96	73,000	125,143	198,143	13.7
1989	4.16	73,000	144,540	217,540	14.3
	17,269.97	1,168,000	969,674	2,137,674	12.4

ALTERNATIVE NO. 4

Conventional plant expansion to 4.0 MGD, P Removal, outlet to Desjardins Canal at York Road. Complete standby facilities, effluent pumps, including engineering and contingencies.

Capital cost of $2,250,000. Operating and maintenance costs 22.83¢/1000 Gals.

Year	Sewage Flow M.G.D.	Annual Capital Cost	Annual Operating & Maintenance Cost	Total Annual Costs	Rate Cost ¢/1000 Gals.
1974	2.00	240,000	166,659	406,659	55.7
1975	2.10	240,000	192,491	432,491	56.4
1976	2.20	240,000	222,327	462,327	57.4
1977	2.32	240,000	256,788	496,788	58.8
1978	2.43	240,000	296,590	536,590	60.5
1979	2.55	240,000	342,562	582,562	62.5
1980	2.68	240,000	395,659	635,659	65.0
1981	2.81	240,000	456,986	696,986	67.9
1982	2.95	240,000	527,819	767,819	71.2
1983	3.10	240,000	609,630	849,630	75.0
1984	3.26	240,000	704,123	944,123	79.4
1985	3.42	240,000	813,262	1,053,262	84.4
1986	3.59	240,000	939,318	1,179,318	90.0
1987	3.77	240,000	1,084,912	1,324,912	96.3
1988	3.96	240,000	1,253,074	1,493,074	103.3
1989	4.16	240,000	1,447,300	1,687,300	111.2
	17,269.97	3,840,000	9,709,499	13,549,499	78.5

ALTERNATIVE NO. 5

Activated carbon plant with sand and carbon filters but without carbon regeneration, including engineering and contingencies.

Capital cost of $1,095,000.
Operating and maintenance costs 29.68¢/1000 Gals.

Year	Sewage Flow M.G.D.	Annual Capital Cost	Annual Operating & Maintenance Cost	Total Annual Costs	Net Cost ¢/1000 Gals.
1974	2.00	116,800	216,664	333,464	45.7
1975	2.10	116,800	250,247	367,047	47.9
1976	2.20	116,800	289,035	405,835	50.4
1977	2.32	116,800	333,836	450,636	53.3
1978	2.43	116,800	385,580	502,380	56.6
1979	2.55	116,800	445,345	562,145	60.3
1980	2.68	116,800	514,374	631,174	64.5
1981	2.81	116,800	594,101	710,901	69.2
1982	2.95	116,800	686,187	802,987	74.5
1983	3.10	116,800	792,546	909,346	80.3
1984	3.26	116,800	915,391	1,032,191	86.8
1985	3.42	116,800	1,057,277	1,174,077	94.0
1986	3.59	116,800	1,221,154	1,337,954	102.1
1987	3.77	116,800	1,410,433	1,527,233	110.9
1988	3.96	116,800	1,629,050	1,745,850	120.8
1989	4.16	116,800	1,881,553	1,998,353	131.7
	17,269.97	1,868,800	12,622,774	14,491,574	83.9

ALTERNATIVE NO. 6

Activated carbon plant with sand and carbon filters and carbon regeneration, including engineering and contingencies.

Capital cost of $1,435,000.
Operating and maintenance costs 9.13¢/1000 Gals.

Year	Sewage Flow M.G.D.	Annual Capital Cost	Annual Operating & Maintenance Cost	Total Annual Costs	Total Cost ¢/1000 Gals.
1974	2.00	153,200	66,649	219,849	30.1
1975	2.10	153,200	76,980	230,180	30.0
1976	2.20	153,200	88,911	242,111	30.1
1977	2.32	153,200	102,693	255,893	30.3
1978	2.43	153,200	118,610	271,810	30.6
1979	2.55	153,200	136,995	290,195	31.1
1980	2.68	153,200	158,229	311,429	31.8
1981	2.81	153,200	182,754	335,954	32.7
1982	2.95	153,200	211,081	364,281	33.8
1983	3.10	153,200	243,799	396,999	35.1
1984	3.26	153,200	281,588	434,788	36.6
1985	3.42	153,200	325,234	478,434	38.3
1986	3.59	153,200	375,645	528,845	40.3
1987	3.77	153,200	433,870	587,070	42.6
1988	3.96	153,200	501,120	654,320	45.3
1989	4.16	153,200	578,793	731,993	43.2
	17,269.97	2,451,200	3,882,949	6,334,149	36.7

ALTERNATIVE NO. 7

Items 1 and 2 above comprise a complete system.

Capital cost of $4,300,000.
Operating and maintenance costs 20.91¢/1000 Gals.

Year	Sewage Flow M.G.D.	Annual Capital Cost	Annual Operating & Maintenance Cost	Total Annual Costs	Unit Cost ¢/1000 Gals.
1974	2.00	459,000	152,643	611,643	83.6
1975	2.10	459,000	176,303	635,303	82.9
1976	2.20	459,000	203,630	662,630	82.3
1977	2.32	459,000	235,192	694,192	82.1
1978	2.43	459,000	271,647	730,647	82.3
1979	2.55	459,000	313,752	772,752	82.9
1980	2.68	459,000	362,384	821,384	84.0
1981	2.81	459,000	418,553	877,553	85.4
1982	2.95	459,000	483,429	942,429	87.4
1983	3.10	459,000	558,361	1,017,361	89.8
1984	3.26	459,000	644,906	1,103,906	92.8
1985	3.42	459,000	744,867	1,203,867	96.4
1986	3.59	459,000	860,321	1,319,321	100.6
1987	3.77	459,000	993,671	1,452,671	105.5
1988	3.96	459,000	1,147,690	1,606,690	111.2
1989	4.16	459,000	1,325,582	1,784,582	117.6
	17,269.97	7,344,000	8,892,932	16,236,932	94.0

ALTERNATIVE NO. 8

Items 3, 4, and 6 above comprise a complete system and complete standby power.

Capital cost of $4,370,000. Operating and maintenance costs 34.25¢/1000 Gals.

Year	Sewage Flow M.G.D.	Annual Capital Cost	Annual Operating & Maintenance Cost	Total Annual Costs	Rate Cost ¢/1000 Gals.
1974	2.00	466,200	250,025	716,225	98.1
1975	2.10	466,200	288,779	754,979	98.5
1976	2.20	466,200	333,540	799,740	99.4
1977	2.32	466,200	385,238	851,438	100.8
1978	2.43	466,200	444,950	911,150	102.7
1979	2.55	466,200	513,917	980,117	105.2
1980	2.68	466,200	593,575	1,059,775	108.3
1981	2.81	466,200	685,579	1,151,779	112.1
1982	2.95	466,200	791,843	1,258,043	116.6
1983	3.10	466,200	914,579	1,380,779	121.9
1984	3.26	466,200	1,056,339	1,522,539	128.0
1985	3.42	466,200	1,220,071	1,686,271	135.1
1986	3.59	466,200	1,409,183	1,875,383	143.1
1987	3.77	466,200	1,627,606	2,093,806	152.1
1988	3.96	466,200	1,879,885	2,346,085	162.3
1989	4.16	466,200	2,171,267	2,637,467	173.8
	17,269.97	7,459,200	14,566,375	22,025,575	127.5

APPENDIX 'B'

TOWN OF DUNDAS
COST ESTIMATES FOR SEWAGE TREATMENT PLANT EXPANSION

Basis:

i. A 10 percent increase will occur annually in population growth and correspondingly in sewage flows.

ii. Operating and maintenance costs will increase 10 percent annually.

ALTERNATIVE NO. 1

Conventional plant expansion to 4.0 MGD, P removal, outlet to Desjardins Canal at York Road. Normal standby facilities, including engineering and contingencies.

Capital cost of $2.1M.
Initial operating costs 20¢/1000 Gals.

Year	Sewage Flow M.G.D.	Annual Capital Cost	Annual Operating & Maintenance Cost	Total Annual Costs	Rate Cost ¢/1000 Gals.
1974	2.00	224,000	146,000	370,000	50.7
1975	2.20	224,000	176,660	400,660	49.9
1976	2.42	224,000	213,759	437,759	49.6
1977	2.66	224,000	258,648	482,648	49.7
1978	2.93	224,000	312,964	536,964	50.2
1979	3.22	224,000	378,686	602,686	51.3
1980	3.54	224,000	458,211	682,211	52.8
1981	3.90	224,000	554,435	778,435	54.7
1982	4.29	224,000	670,866	894,866	57.2
	9,913.02	2,016,000	3,170,228	5,186,228	52.3

ALTERNATIVE NO. 2

Outlet from 4.0 MGD plant to Hamilton Harbour, including booster pump and engineering and contingencies.

Capital cost of $2,200,000.
Operating and maintenance costs 0.91¢/1000 Gals.

Year	Sewage Flow M.G.D.	Annual Capital Cost	Annual Operating & Maintenance Cost	Total Annual Costs	Rate Cost ¢/1000 Gals.
1974	2.00	235,000	6,643	241,643	33.1
1975	2.20	235,000	8,038	243,038	30.3
1976	2.42	235,000	9,726	244,726	27.7
1977	2.66	235,000	11,768	246,768	25.4
1978	2.93	235,000	14,240	249,240	23.3
1979	3.22	235,000	17,230	252,230	21.5
1980	3.54	235,000	20,849	255,849	19.8
1981	3.90	235,000	25,227	260,227	18.3
1982	4.29	235,000	30,524	265,524	17.0
	9,913.02	2,115,000	144,245	2,259,245	22.8

ALTERNATIVE NO. 3

High flow surge tank, including engineering and contingencies.

Capital cost of $685,000.
Operating and maintenance costs 2.28¢/1000 Gals.

Year	Sewage Flow M.G.D.	Annual Capital Cost	Annual Operating & Maintenance Cost	Total Annual Costs	Rate Cost ¢/1000 Gals.
1974	2.00	73,000	16,644	89,644	12.3
1975	2.20	73,000	20,139	93,139	11.6
1976	2.42	73,000	24,368	97,368	11.0
1977	2.66	73,000	29,486	102,486	10.5
1978	2.93	73,000	35,678	108,678	10.2
1979	3.22	73,000	43,170	116,170	9.9
1980	3.54	73,000	52,236	125,236	9.7
1981	3.90	73,000	63,206	136,206	9.6
1982	4.29	73,000	76,479	149,479	9.6
	9,913.02	657,000	361,406	1,018,406	10.3

ALTERNATIVE NO. 4

Conventional plant expansion to 4.0 MGD, P removal, outlet to Desjardins Canal at York Road. Complete standby facilities, effluent pumps, including engineering and contingencies.

Capital cost of $2,250,000.
Operating and maintenance costs 22.83¢/1000 Gals.

Year	Sewage Flow M.G.D.	Annual Capital Cost	Annual Operating & Maintenance Cost	Total Annual Costs	Rate Cost ¢/1000 Gals.
1974	2.00	240,000	166,659	406,659	55.7
1975	2.20	240,000	201,657	441,657	55.0
1976	2.42	240,000	244,005	484,005	54.8
1977	2.66	240,000	295,247	535,247	55.1
1978	2.93	240,000	357,248	597,248	55.9
1979	3.22	240,000	432,271	672,271	57.2
1980	3.54	240,000	523,047	763,047	59.0
1981	3.90	240,000	632,887	872,887	61.4
1982	4.29	240,000	765,794	1,005,794	64.3
	9,913.02	2,160,000	3,618,816	5,778,816	58.3

ALTERNATIVE NO. 5

Activated carbon plant with sand and carbon filters but without carbon regeneration, including engineering and contingencies.

Capital cost of $1,095,000. Operating and maintenance costs 29.68¢/1000 Gals.

Year	Sewage Flow M.G.D.	Annual Capital Cost	Annual Operating & Maintenance Cost	Total Annual Costs	Rate Cost ¢/1000 Gals.
1974	2.00	116,800	216,664	333,464	45.7
1975	2.20	116,800	262,163	378,963	47.2
1976	2.42	116,800	317,218	434,018	49.1
1977	2.66	116,800	383,833	500,633	51.5
1978	2.93	116,800	464,439	581,239	54.4
1979	3.22	116,800	561,971	678,771	57.7
1980	3.54	116,800	679,984	796,784	61.6
1981	3.90	116,800	822,781	939,581	66.0
1982	4.29	116,800	995,565	1,112,365	71.1
	9,913,02	1,051,200	4,704,619	5,755,819	58.1

ALTERNATIVE NO. 6

Activated carbon plant with sand and carbon filters and carbon regeneration, including engineering and contingencies.

Capital cost of $1,435,000. Operating and maintenance costs 9.13¢/1000 Gals.

Year	Sewage Flow M.G.D.	Annual Capital Cost	Annual Operating & Maintenance Cost	Total Annual Costs	Avg. Cost ¢/1000 Gals.
1974	2.00	153,200	66,649	219,849	30.1
1975	2.20	153,200	80,645	233,845	29.1
1976	2.42	153,200	97,581	250,781	28.4
1977	2.66	153,200	118,073	271,273	27.9
1978	2.93	153,200	142,868	296,068	27.7
1979	3.22	153,200	172,870	326,070	27.7
1980	3.54	153,200	209,173	362,373	28.0
1981	3.90	153,200	253,099	406,299	28.6
1982	4.29	153,200	306,250	459,450	29.4
	9,913.02	1,378,800	1,447,209	2,826,009	28.5

ALTERNATIVE NO. 7

Items 1 and 2 above comprise a complete system.

Capital cost of $4,300,000. Operating and maintenance costs 20.91¢/1000 Gals.

Year	Sewage Flow M.G.D.	Annual Capital Cost	Annual Operating & Maintenance Cost	Total Annual Costs	Rate Cost ¢/1000 Gals.
1974	2.00	459,000	152,643	611,643	83.8
1975	2.20	459,000	184,698	643,698	80.2
1976	2.42	459,000	223,485	682,485	77.3
1977	2.66	459,000	270,416	729,416	75.1
1978	2.93	459,000	327,204	786,204	73.6
1979	3.22	459,000	395,917	854,917	72.7
1980	3.54	459,000	479,059	938,059	72.5
1981	3.90	459,000	579,662	1,038,662	73.0
1982	4.29	459,000	701,390	1,160,390	74.2
	9,913.02	4,131,000	3,314,474	7,445,474	75.1

ALTERNATIVE NO. 8

Items 3, 4, and 6 above comprise a complete system and complete standby power.

Capital cost of $4,370,000.
Operating and maintenance costs 34.25¢/1000 Gals.

Year	Sewage Flow M.G.D.	Annual Capital Cost	Annual Operating & Maintenance Cost	Total Annual Costs	Rate Cost ¢/1000 Gals.
1974	2.00	466,200	250,025	716,225	98.1
1975	2.20	466,200	302,530	768,730	95.7
1976	2.42	466,200	366,062	832,262	94.2
1977	2.66	466,200	442,935	909,135	93.6
1978	2.93	466,200	535,951	1,002,151	93.8
1979	3.22	466,200	648,500	1,114,700	94.8
1980	3.54	466,200	784,686	1,250,886	96.7
1981	3.90	466,200	949,470	1,415,670	99.5
1982	4.29	466,200	1,148,858	1,615,058	103.2
	9,913.02	4,195,800	5,429,016	9,624,816	97.1

APPENDIX 'C'

DESIGN PARAMETERS FOR PROPOSED CONVENTIONAL ACTIVATED SLUDGE PROCESS

Flow:

Average: 2.5 mgd

Peak: 2.0x2.5 mgd = 5.0 mgd + waste activated sludge produced by adjacent 1.5 mgd conventional activated sludge plant.

Strength:

Raw sewage	BOD	-	180 ppm
	SS	-	180 ppm
	P	-	>10 ppm

Secondary effluent	BOD	-	15 ppm
+ nutrient removal	SS	-	15 ppm
	P	-	1.0 ppm

DESIGN PARAMETERS FOR OPTIONAL CARBON ABSORPTION SYSTEM

Flow:

Average: 4.0 mgd

Peak: 2x4.0 mgd = 8 mgd

Surface loading on roughing filter - 4 gal/ft^2/min. at 4.0 mgd

Strength:

To roughing filter	BOD	-	15 ppm
	SS	-	15 ppm
	P	-	1.0 ppm
From roughing filter	BOD		<10 ppm
	SS	-	< 5 ppm
	P		1.0 ppm

Carbon columns:

To columns -	BOD	10 ppm	From columns -	BOD	2-4 ppm
	SS	5 ppm		SS	1 ppm
	P	1.0 ppm		P	1 ppm

Carbon to be regenerated - 5 lbs. per lb. BOD removed.

Type of furnace - Multi-Tier Rotary Kiln - 20" I.D.

DESIGN PARAMETERS FOR SURGE TANK

Max. hour rate = 2.6xDWF = 10.4 mgd

Capacity of biological system = 8.0 mgd

∴ Excess flow = 2.4 mgd

Max. 10 hour flow = 1.0 mg

∴ Capacity of surge tank = 1.0 mg

DESIGN PARAMETERS FOR OUTFALL PIPE

Design parameters for outfall sewer to Hamilton Harbour restricted by max. size of plastic pipe now manufactured which is 48" O.D. This would enable 2xDWF by gravity - excess flows would be pumped by booster pump.

Western Photogrammetry Limited
Offices

89 Carlingview Drive, Rexdale, Ontario M9W 5E4

11831 - 123 Street, Edmonton, Alberta T5L 0G7

or
at any UMA Group Office

1005 - 555 Burrard Street, Vancouver, B.C. V7X 1M2
#200 - 6545 Bonsor Avenue, Burnaby, B.C. V5H 1H3
2540 Kensington Road, N.W., Calgary, Alberta T2N 3S3
1479 Buffalo Place, Winnipeg, Manitoba R3T 1L7
Box 539, Saskatoon, Saskatchewan S7K 3L6